THE NEWS LETTER
OF THE
BUREAU OF PUBLIC ROADS

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U. S. TO PLAY HOST TO EUROPEAN ROAD BUILDERS IN 1930

Leading highway officials from all parts of the world are coming to the United States in 1930 to study American methods of road improvement and road use, according to word brought back by Mr. MacDonald from the recent sessions of the International Road Commission held in Paris. Mr. MacDonald went to France as head of the official delegation representing the American Government at the road meeting. He later made an investigation into the phases of highway development in many of the countries of Western Europe and in the British Isles.

Interest In Program

"Not only was the invitation extended by our Congress through President Coolidge accepted unanimously," said Mr. MacDonald, "but from comments of delegates from other countries, it is evident there is a deep-rooted, world-wide interest in what is being done to improve highways here.

"The great distinction which exists between our program and that of other nations, is that while here the whole country has adopted motor transportation, elsewhere car use is still largely in the hands of a few.

"The rapid expansion in the United States faced our engineers with an urgent demand for the immediate improvement of hundreds of thousands of miles of highway. At the same time, increased valuations growing out of bettered transportation facilities and a moderate tax upon the vehicle itself made it actually cheaper for the public to have roads than to go without them, so that we were able to embark upon a construction program without parallel in the history of public works without dislocating our financial system.

"Concurrently, we were faced with the question of whether it was cheaper to build these roads slowly and laboriously by human labor as most other countries now do, or whether we should work out mass production methods and so meet the national demand quickly. Experience has demonstrated that the latter plan is by far the more efficient and less costly.

Same Problems Face Other Nations

"Foreign highway engineers, who are as well or better versed in the technique of road building as our own men, in the main are only now arriving at the stage where they must meet similar problems in their own countries, hence their interest in the sessions here in 1930.

"Further, because of the wide diversity of geographical, climatic and soil conditions in the United States, coupled with varying degrees of wealth and population, it is possible to approximate here the basic problems which confront engineers from abroad, whether they are interested in congested areas, such as England has, in primary roads, such as are needed in the newer countries, or in questions of mountain roads such as those faced by Austria, Switzerland and other nations.

United States Giant Laboratory

"So, the United States in 1930 will be a giant laboratory in highway development and motor transportation where highway officials from other countries will find an opportunity to see not only what has been accomplished from an engineering point of view, but also to observe both the social and economic influences which have been effected.

"At the same time, our engineers will have an opportunity to learn what is being done in other countries and to compare notes with their foreign colleagues."

ANNUAL MEETING OF THE A.A.S.H.O. TO BE HELD IN CHICAGO

The annual meeting of the American Association of State Highway Officials will be held in Chicago from November 12 to 15, 1928. The Stevens hotel on Michigan Boulevard has been chosen for headquarters. This large hotel, containing over 3,000 rooms, enables the Association to obtain accommodations for an Assembly Room and Committee Rooms all on the third floor. There are several matters of vital importance to the development and service of the State highway departments that will be discussed at this meeting.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

CURRENT CONDITION OF FEDERAL AID ROAD WORK

AS OF AUGUST 31, 1928

STATE	BALANCE OF FEDERAL AID AVAILABLE FOR NEW PROJECTS	P. S. & E. RECOMMENDED FOR APPROVAL						PROJECT AGREEMENTS EXECUTED									PAID TO STATES DURING FISCAL YEAR	STATE
		NOT YET UNDER CONSTRUCTION			UNDER CONSTRUCTION			NOT YET UNDER CONSTRUCTION			UNDER CONSTRUCTION			FINAL INSPECTION MADE				
		FEDERAL AID ALLOTTED	MILEAGE INITIAL	MILEAGE STAGE	FEDERAL AID ALLOTTED	MILEAGE INITIAL	MILEAGE STAGE	FEDERAL AID ALLOTTED	MILEAGE INITIAL	MILEAGE STAGE	FEDERAL AID ALLOTTED	MILEAGE INITIAL	MILEAGE STAGE	FEDERAL AID ALLOTTED	MILEAGE INITIAL	MILEAGE STAGE		
ALABAMA	$ 1,344,915.31	$ 430,013.32	45.2	12.4	$ 316,314.31	62.2		$			$2,047,177.12	240.4	31.2	$1,644,481.46	160.4	24.7	$ 522,371.64	ALABAMA
ARIZONA	2,783,937.59	112,087.06	7.5	.1	8,663.32		1.8				1,280,937.23	66.8	3.0	616,706.80	64.0	4.3	491,393.07	ARIZONA
ARKANSAS	1,745,672.16	116,258.35	9.9	6.6	189,978.19	32.0					2,001,203.01	148.7		231,817.71	45.9		299,010.67	ARKANSAS
CALIFORNIA	2,579,925.07	439,468.16	33.3		384,892.33	17.6	1.0	285,060.22	15.0		3,243,829.83	159.3	8.3	212,940.19	8.5		335,770.81	CALIFORNIA
COLORADO	2,068,504.12	412,383.94	25.4	14.5	612,666.12	24.3		45,776.43	8.2		2,175,644.48	170.3	9.2	419,926.31	34.3		345,538.05	COLORADO
CONNECTICUT	566,762.61							66,961.17	3.6		697,011.44	33.3		826,705.00	29.4			CONNECTICUT
DELAWARE	149,880.44	40,800.00	2.7					165,296.80	12.9		95,739.75	5.7	4.0					DELAWARE
FLORIDA	1,212,651.02	269,730.00	18.0					63,776.44	12.7		1,547,155.98	83.9	5.4	95,692.15	9.9		302,631.43	FLORIDA
GEORGIA	4,406.00	610,125.59	80.1	8.4	491,907.37	25.3	30.8	157,912.31	7.3	10.0	1,736,668.77	168.2	21.6	201,282.25	33.7	9.1	375,502.50	GEORGIA
IDAHO	85,032.18	431,569.23	81.9		149,883.12	11.2	11.2	260,369.13	30.1	1.9	970,033.17	81.0	43.4	77,082.71	11.5	10.0	233,484.80	IDAHO
ILLINOIS	27,550.17	1,021,021.40	80.2		2,482,987.48	174.9					7,517,211.62	499.6		781,372.80	56.0		372,894.29	ILLINOIS
INDIANA	127,949.39	412,610.00	32.9		421,497.79	23.0		151,609.27	11.3		4,113,437.21	266.4	3.5	1,497,351.10	104.1		407,430.10	INDIANA
IOWA	171,313.77							565,111.52	5.1	60.3	2,658,186.52	126.0	127.9	617,567.03	24.2	29.1	154,284.56	IOWA
KANSAS	393,230.20	1,182,100.59	194.4	16.3	23,105.96	6.1		111,017.37	19.3		1,887,662.76	252.4		1,896,000.12	205.7	0.4	354,837.15	KANSAS
KENTUCKY	8,677.83	705,734.17	87.1		654,899.90	52.1					1,929,025.25	179.7		1,014,495.22	76.7	16.5	231,558.43	KENTUCKY
LOUISIANA	437,598.06	129,923.62	3.2		96,438.51	19.5					1,980,649.09	178.9		128,913.41	7.9		240,499.07	LOUISIANA
MAINE	1,015,874.53	329,766.87	25.1		35,355.00	2.4		200,582.36	14.2		528,952.60	39.7		125,222.11	9.3			MAINE
MARYLAND	39,571.23	277,945.00	20.8	7.2	36,330.00	2.4		243,200.00	26.8		233,300.00	20.2					135,200.62	MARYLAND
MASSACHUSETTS	1,662,884.46	369,172.14	20.9		164,940.00	11.0					1,038,267.82	65.0		675,145.08	39.4		273,485.06	MASSACHUSETTS
MICHIGAN	338,729.95	410,245.00	22.2	6.5	995,325.00	59.1					4,936,623.08	300.3		349,012.72	20.5		918,780.92	MICHIGAN
MINNESOTA	393,471.43	(*)	22.3		85,000.00	15.8	2.0	129,000.00	12.5	20.6	2,038,100.00	306.7	54.7	132,000.00	20.7		943,866.22	MINNESOTA
MISSISSIPPI	562,842.23	315,048.71	22.2		280,733.50	10.2	0.7				1,991,730.97	226.1	30.9	306,363.55	30.4	9.0	198,097.92	MISSISSIPPI
MISSOURI	1,015,305.04	602,737.35	53.3	7.9	494,732.93	39.2	5.0	91,502.26	2.3	5.0	1,774,002.01	126.8	39.8	1,013,192.46	64.2	9.4	414,275.08	MISSOURI
MONTANA	4,339,426.40	63,374.67	2.0	8.8	4,442.91	.1		645,191.74	125.5	4.5	2,415,605.72	349.9	7.4	984,544.57	90.7		443,378.55	MONTANA
NEBRASKA	1,894,612.04	126,212.20	20.5	5.0	71,814.48	15.0		34,800.74		23.2	2,679,231.06	539.8	153.4	1,435,348.15	285.8	144.3	327,294.03	NEBRASKA
NEVADA	450,391.64	126,000.99	.4	23.0	28,352.98		8.5	6,696.84		2.8	727,755.52	96.9	27.9	696,688.05	83.2	64.3	174,506.15	NEVADA
NEW HAMPSHIRE	615.07	63,735.00	4.2		26,550.00	1.8		114,140.78	4.2		324,415.16	22.4		150,890.42	8.4		12,778.96	NEW HAMPSHIRE
NEW JERSEY	86,765.94	124,005.00	8.3		507,105.00	33.8					432,072.35	30.8		199,635.00	13.3		172,670.23	NEW JERSEY
NEW MEXICO	454,073.83	379,284.48	34.1		690,498.50	78.6		5,480.35	0.3		1,192,210.57	105.1	.5	1,806,950.94	160.6		231,695.56	NEW MEXICO
NEW YORK	3,554,470.63	220,360.00	14.7					1,531,605.00	102.2		7,243,397.50	464.6	8.6	700,587.50	36.5		550,503.41	NEW YORK
NORTH CAROLINA	765,695.89	271,029.10	14.0	12.2	484,119.03	6.5	7.3	47,500.00	4.9		638,639.02	71.9	13.0	492,258.43	23.1		273,777.91	NORTH CAROLINA
NORTH DAKOTA	423,325.32	155,154.71	44.9	43.7	89,817.40	17.4	17.0	201,037.30	89.2	54.2	1,542,899.12	608.4	133.1	817,107.14	221.5	123.2	333,266.39	NORTH DAKOTA
OHIO	1,692,111.86	1,333,791.04	81.1	12.7	619,160.00	44.4	.1	282,890.00	18.8		3,912,138.32	230.0	5.9	917,717.81	67.3		556,101.37	OHIO
OKLAHOMA	332,154.21	743,706.50	99.3	20.4	255,971.05	5.4	6.3	72,420.00	4.8		1,333,754.78	160.4		964,697.74	156.9	12.8	369,699.10	OKLAHOMA
OREGON	1,226,909.14	76,680.28	14.0		31,050.54			35,054.74	.1		880,160.98	45.3		176,047.08	10.9	9.2	79,451.71	OREGON
PENNSYLVANIA	1,092,795.47	872,981.36	55.8		208,755.05	13.6		789,812.49	49.1		3,722,062.68	227.8		1,350,669.54	78.2		559,362.90	PENNSYLVANIA
RHODE ISLAND	576,046.16							43,974.55	1.6		248,919.92	14.7		219,075.00	14.6		112,009.78	RHODE ISLAND
SOUTH CAROLINA	66,660.90				190,000.00	7.8	23.3	45,000.00		8.2	1,586,674.99	187.3	97.4	775,337.97	93.0	40.9	278,254.20	SOUTH CAROLINA
SOUTH DAKOTA	311,479.70	107,738.58	73.0	9.5	61,072.56	8.4	11.5	86,034.71	28.2	12.3	1,624,235.31	502.7	70.2	782,276.75	219.2	75.6	386,182.57	SOUTH DAKOTA
TENNESSEE	255,543.76	1,166,299.31	25.6	84.9	1,092,998.87	56.6		96,690.77		9.4	844,376.33	70.5		1,909,407.77	122.6	23.8	127,278.13	TENNESSEE
TEXAS	3,400,336.71	1,954,155.89	137.8	96.9	1,135,797.55	29.0	10.7	678,043.41	89.4	37.6	2,790,269.07	197.0	145.6	1,656,510.66	171.4	41.9	646,988.73	TEXAS
UTAH	39,574.75	306,278.79	30.9	54.2	91,291.55	3.6		43,597.55	8.3		994,812.78	80.1	5.4	640,420.46	53.4		148,229.88	UTAH
VERMONT	38,964.23							55,000.00	6.3		663,942.33	54.5					45,331.31	VERMONT
VIRGINIA	11,604.44	234,117.93	30.7		244,271.74	12.6	7.8	129,187.05	25.0		1,078,901.70	86.6	13.8	438,909.21	26.8		273,683.20	VIRGINIA
WASHINGTON	479,924.08	243,166.27	16.1	5.0	158,000.00	8.5		233,000.00	8.4		1,245,000.00	96.9	18.1	110,600.00	18.9			WASHINGTON
WEST VIRGINIA	248,198.88	529,006.09	39.6	12.4	67,913.20	6.7					1,172,262.05	98.9		682,798.33	65.5	4.0		WEST VIRGINIA
WISCONSIN	1,437,126.56	114,502.59	10.1	7.8	750,464.05	62.5	15.4	31,263.00	4.8	2.1	2,347,759.65	209.4	12.1	1,142,349.55	88.7	11.1	23,318.07	WISCONSIN
WYOMING	35,095.74	88,536.41	16.9		251,531.84	55.9					1,266,198.39	200.9	26.2	150,878.71	21.7	5.9	362,303.03	WYOMING
HAWAII	1,064,241.58							67,501.20	1.8		60,383.43	3.2		178,717.46	9.1		27,764.14	HAWAII
TOTALS	43,014,819.81	17,918,737.49	1,661.4	476.4	14,886,619.03	1,046.5	160.4	7,793,184.50	754.2	262.0	91,290,428.34	8,501.2	1,121.6	32,143,694.42	3,187.9	372.5	14,066,741.69	TOTALS

(*) PROJECT SUBSTITUTION - NO NEW FEDERAL AID ALLOTTED

COST STUDIES ON THE CONSTRUCTION OF A CALIFORNIA FOREST HIGHWAY PROJECT

COMPILED FROM A REPORT SUBMITTED BY
R. H. TATLOW III, OF THE DIVISION OF MANAGEMENT
(NOT FOR RELEASE)

COST STUDIES ON THE GRADING OPERATIONS OF A 10-MILE SECTION OF THE BEAR VALLEY NATIONAL FOREST HIGHWAY NORTH OF SAN BERNARDINO, CALIF., AS SHOWN IN FIGURES 1 AND 2, GIVE SOME INTERESTING STATISTICS WITH REGARD TO THE RELATIVE COST OF STEAM AS COMPARED WITH GAS-AIR POWER SHOVELS, AND OF STANDARD MOTOR TRUCKS AS CONTRASTED WITH LINN TRACTORS. ALTHOUGH THE RESULTS ARE INCONCLUSIVE BECAUSE OF THE DIFFERENT AGES AND SIZES OF THE SHOVELS AND TRUCKS, THEY ARE VALUABLE AS AN INDICATION OF WHAT IS POSSIBLE UNDER CERTAIN GOVERNING CONDITIONS.

THE STUDY SHOWED THAT THE STEAM SHOVELS WERE MUCH FASTER ON THE SWING THAN THE GAS-AIR SHOVELS ALTHOUGH THEY SEEMED TO LACK THE HOISTING POWER OF THE AIR SHOVELS. THIS SEEMED TO BE ACCOUNTED FOR BY THE FACT THAT THE GREATER HORSEPOWER OF THE GASOLINE ENGINE WAS MADE STILL MORE EFFECTIVE BY A DIRECT HOISTING MECHANISM. THE STEAM SHOVEL HAD THE ADVANTAGE, ALSO, IN AVERAGE DUMPING TIME, 2.46 SECONDS AS COMPARED WITH 3.42 SECONDS, BECAUSE OF THE POOR REVERSING DEVICE ON THE GAS-AIR SHOVELS. THE SWING OF THE LATTER WAS NEVER RELIABLE AND COULD NOT BE JUDGED ACCURATELY. OCCASIONALLY THE BOOM WOULD STOP SUDDENLY AND AT OTHER TIMES THE BUCKET WOULD BE SWUNG CLEAR OVER THE TRUCK. THE DELAYS, CAUSED BY MECHANICAL DEFECTS AND REPAIR ON THE STEAM SHOVELS, AVERAGED ONLY 21 PER CENT OF THOSE ON THE GASOLINE SHOVELS. THESE CHARACTERISTICS PERHAPS ACCOUNT FOR THE FACT THAT THE PRODUCTION OF THE GAS-AIR SHOVELS WAS ONLY FROM 10 TO 20 PER CENT HIGHER THAN THAT OF THE STEAM SHOVELS, ALTHOUGH THE STEAM SHOVELS HAD A CAPACITY OF ONLY 7/8 OF A CUBIC YARD WHILE THOSE ON THE GAS-AIR SHOVELS HELD 1-1/8 CUBIC YARDS. IN THE FACILITY WITH WHICH FUEL COULD BE DELIVERED, HOWEVER, THE GAS-AIR SHOVELS HAD THE DECIDED ADVANTAGE.

UNFORTUNATELY THE MOTOR TRUCKS ON THE PROJECT WERE OLD MODELS AND ANY COMPARISON WOULD NATURALLY FAVOR THE NEW LINN TRACTORS WHICH HAD AN ADDED ADVANTAGE IN THEIR ABILITY TO MAINTAIN THEIR OWN ROADS - THE CATERPILLARS KEEPING THE TRAVELLED

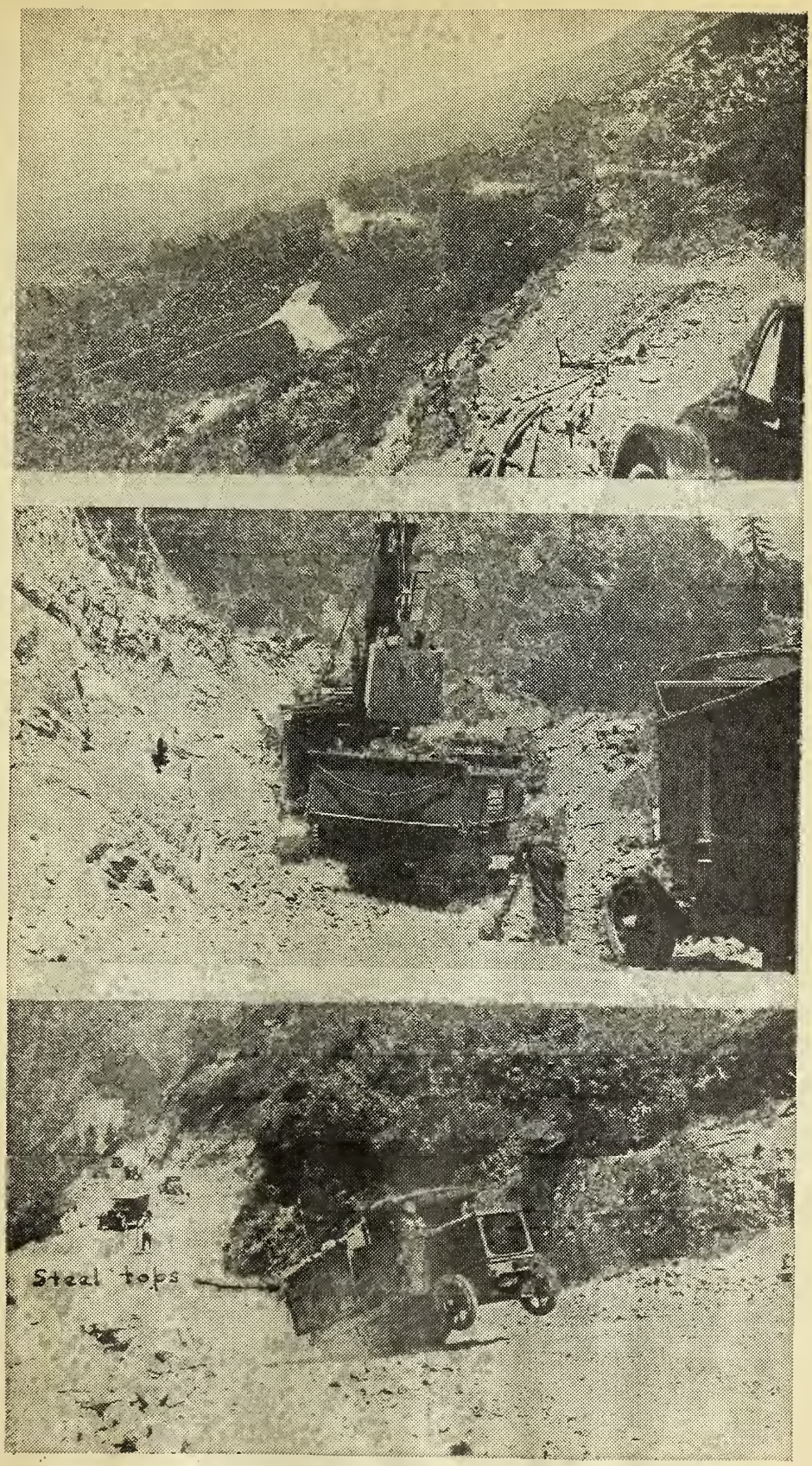


Figure 1. – (Top) General view of the topography of the project.
(Center) Gas-air shovel loading the steel-bodied Linn tractors from a hard strata of granite.
(Bottom) Linn tractor, with wood body extended by steel tops, tipping up on a 30 per cent grade.

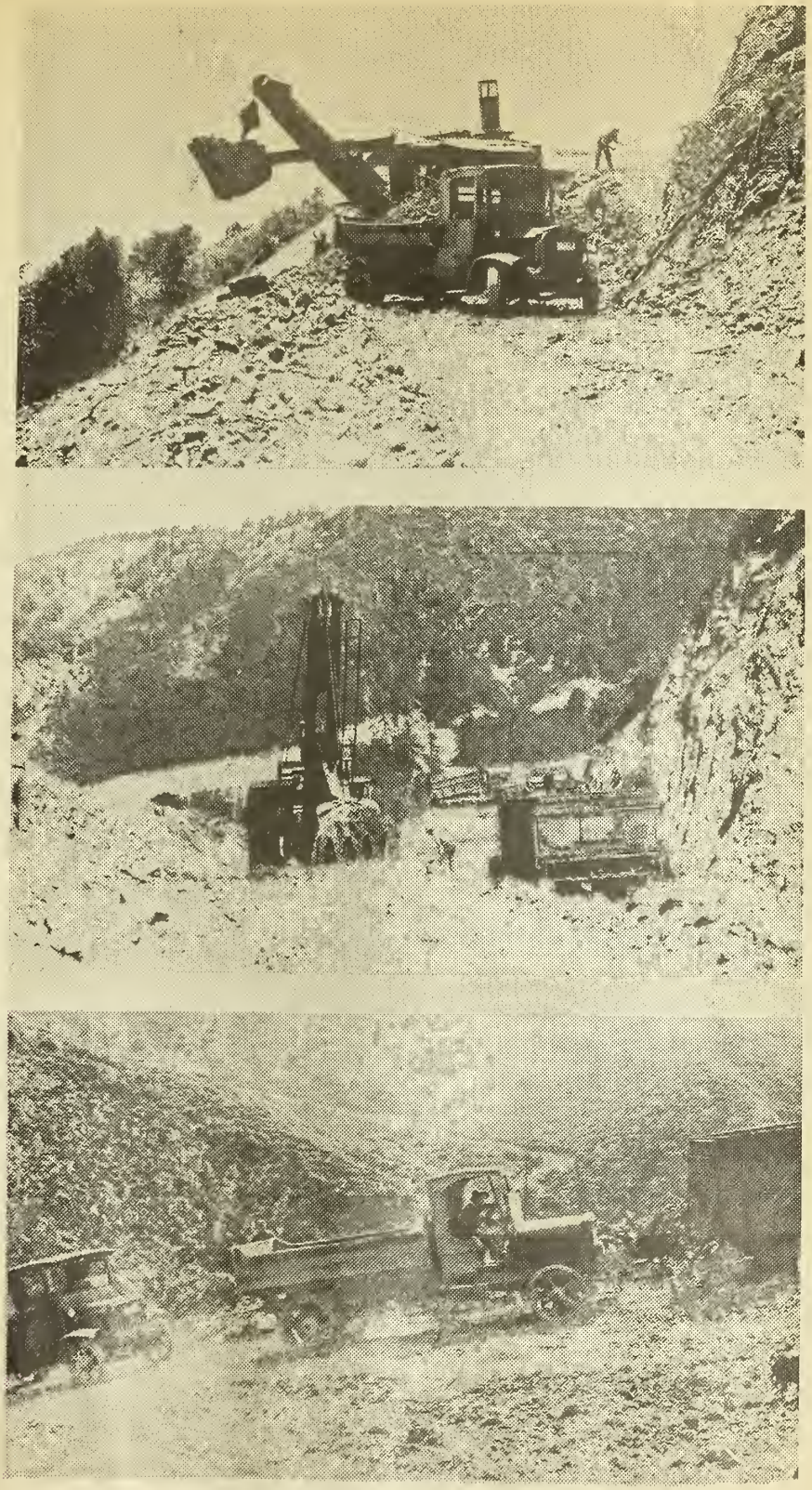


Figure 2. - (Top) Steam shovel in decomposed granite loading an old Federal truck.
(Center) Gas-air shovel loading a Linn tractor with a capacity of 8 cubic yards. The excavation is decomposed granite with a maximum depth of 78 feet.
(Bottom) This Linn tractor pulled these two trucks up a 25 per cent grade which the trucks were unable to climb alone.

WAY SMOOTH AND FREE FROM RUTS AND HOLES AT ALL TIMES. IT SHOULD ALSO BE STATED THAT WHILE THE STUDIES WERE IN PROGRESS HAULS WERE SHORT AND GRADES HEAVY - SOMETIMES OVER 30 PER CENT - BOTH CONDITIONS FAVORABLE FOR THE TRACTORS AND DIFFICULT FOR THE TRUCKS. THE DATA INDICATED THAT THE COST OF HAULING WAS FROM 80 TO 85 PER CENT GREATER FOR THE TRUCKS THAN FOR THE LINN TRACTORS.

GENERAL DESCRIPTION OF PROJECT

THE COST STUDIES WERE BEGUN ON MAY 7 AND CONTINUED UNTIL JUNE 16, 1928, A PERIOD OF SIX WEEKS, ON A FOREST HIGHWAY JOB ESTIMATED TO REQUIRE 300 DAYS FOR COMPLETION. THE WORK (CALIF. F.A.P. 601) INCLUDED 450,699 CUBIC YARDS OF UNCLASSIFIED EXCAVATION TOGETHER WITH CONSIDERABLE CLEARING. THE EXCAVATION CONSISTED PRINCIPALLY OF DECOMPOSED GRANITE WHICH IN PLACES WAS EASY STEAM-SHOVEL WORK AND AT OTHER LOCATIONS REQUIRED BLASTING AS A PRELIMINARY OPERATION. BECAUSE THE GRADE WAS INACCESSIBLE AT ONE END, IT WAS NECESSARY FOR THE CONTRACTOR TO CONSTRUCT APPROACHES. TWO OF THESE ROADS, FOR HAULING SUPPLIES FOR THE SHOVELS, WERE BUILT TO CONNECT THE ROAD WITH THE CAMP WHICH WAS CENTRALLY LOCATED ON THE PROJECT.

THE CLEARING WAS A SERIOUS PROBLEM BECAUSE OF THE DANGER OF FOREST FIRES. FOR THIS REASON BURNING WAS PERMITTED ONLY ON FOGGY DAYS OR FOLLOWING A RAIN WHEN THE LEAF MOLD WAS WET. AT THESE TIMES ALL THE MEN AVAILABLE, WITHOUT STOPPING THE SHOVELS, WERE WITHDRAWN FROM OTHER ACTIVITIES ON THE PROJECT AND ASSIGNED TO THE IGNITION AND CONTROL OF THE FIRES. THIS WAS AN EXPENSIVE OPERATION AND WAS LARGELY RESPONSIBLE FOR THE FAILURE TO MAINTAIN A SUFFICIENT STRETCH OF ROAD BLASTED AHEAD OF THE SHOVELS SO AS TO AVOID ANY DELAYS.

THE GENERAL FOREMAN IN CHARGE OF THE SHOVELS WAS RESPONSIBLE FOR MUCH OF THE PROGRESS MADE. UNDER HIS DIRECTION A MECHANIC WAS EMPLOYED WHO INSPECTED DAILY EVERY SHOVEL AND COMPRESSOR, TOGETHER WITH OTHER MECHANICAL EQUIPMENT. WHERE ANY TROUBLE MANIFESTED ITSELF, REPAIRS WERE MADE EITHER IMMEDIATELY, OR DURING THE SHUTDOWN AT NOON OR IN THE EVENING. THIS KEPT DOWN TO THE MINIMUM ANY LONG COSTLY REPAIRS.

The furnishing of fuel and water for all of the shovels presented a troublesome problem and caused the total operating costs of the steam shovels to be rather high. The water was piped from a spring on top of the ridge - a thousand feet above the grade - and a line was laid over one half of the project with the intention of using gasoline shovels on the other half. The fuel for the steam shovels was especially difficult to transport. It was piped to the shovels wherever possible by gravity but in some cases it was necessary to force the oil through a long pipe line by compressed air. Fuel supply for the gas-air shovels and the motor trucks was greatly facilitated by the Standard Oil Company which delivered the gasoline directly to the several units on the job.

The trucking was accomplished mainly by the contractor with his own equipment, although three trucks were rented by the day. The trucks on the job were in fair condition but were superannuated types and slow acting. The truck hoists were slow and caused considerable delay. The first two Linn tractors were operated with considerable success. These were equipped with 7-cubic-yard steel bodies with underbody hoists but the rear caterpillars were too narrow, and on this account one of the tractors overturned. The transmissions in these first two tractors had only one reverse speed. The next two Linns that were purchased had 6-cubic-yard wooden bodies lined with steel and the caterpillars were spaced about 18 inches farther apart. They also had a vertical hoist, and the transmission was reversible so as to give equal speeds in either direction - a distinct advantage. The capacity of the 6-cubic-yard Linns was increased to 8.2 cubic yards by building up the sides 10 inches with steel plates. A similar increase in the capacity of the steel Linns was not believed to be advisable because the underbody hoist was not considered of sufficient strength to elevate the added load.

The shovels were the key equipment and their rate of production varied from 20 to 175 cubic yards per hour depending upon the loading conditions and the character of the excavation. There were several delays caused by slides and hard materials that could have been forestalled by more careful supervision, but on the whole the project was well managed. All along the project the side slopes were too steep for the material encountered but, because of the dry weather, this factor did not cause excessive delay. The general conclusion was that what time losses occurred could have been reduced by drilling deeper and

loading the blasting holes more heavily. This would have increased the production of the shovels by facilitating the digging.

Comparison of Costs

The average time loss over the 46-day period of inspection was nearly 58 hours for each steam shovel as compared with 99 hours for each gas-air as may be seen in detail in Table 1, The summary in Table 2 gives an estimated average daily cost of time losses amounting to $10.19 for each steam shovel as compared with $17.55 for each gas-air. The estimated daily cost of operation for both types of shovels including interest on the investment, depreciation, fuel, repairs, water, labor, etc., was the same - $65.00.

As indicated in Table 3 the estimated production based on the stop-watch studies was less for the steam than for the gas-air shovels. The net difference, however, varied greatly with the angle of swing. The production for the gas-air shovels was 23 per cent greater than that of the steam shovels on the 45-degree swing but only 10 per cent greater on the 180-degree swing. This was caused by the greater swinging speed of the steam shovels and indicates the degree to which this feature may increase the production of a shovel even though the dipper capacity is relatively small. The estimated costs per cubic yard should not be considered as representing actual costs but merely as relative costs. Actual costs can only be determined by a complete study made throughout the entire duration of the project.

In Table 4 is a comparison between the relative efficiency of the Linn tracotrs and the motor trucks. Regardless of the length of haul up to 350 feet the hauling costs of the trucks exceeded those of the Linn tractors by about 80 per cent. These costs are estimated on the basis of a total daily cost of $25.00 for Linn tractors and trucks. This includes capital costs, repairs, fuel, and driver. The Linns hauled 6 cubic yards to the load and the trucks 3.5 cubic yards. The round-trip time for the trucks averaged slightly greater than that of the Linn tractors. An advantage of the Linns was their ability to climb steep grades with ease. However, on grades over 30 per cent the loaded Linns tipped up on the rear caterpillars lifting the front wheels clear of the ground. This caused no delay except when they turned sidewise on the road and so prevented the normal steering operation.

TABLE 1.- TOTAL DELAYS IN HOURS, FOR 46 DAYS OPERATION, DISTRIBUTED IN AVERAGE HOURS TO EACH OF THE 5 SHOVELS.

KIND OF DELAY	AVERAGE HOURS PER SHOVEL	
	STEAM	GAS-AIR
MECHANICAL		
FUEL	2.92	
REPAIRS	7.33	64.25
TRUCK OPERATION	1.58	
WATER	1.67	
SUB TOTAL	13.50	64.25
WEATHER	16.50	8.75
MISCELLANEOUS		
BLAST	2.00	0.50
MOVING	4.25	1.63
ROCK	0.33	7.00
SLIDE	2.42	
SLOPE		1.25
SUNDAYS	18.67	16.00
SUB TOTAL	27.67	26.38
TOTAL	57.67	99.38

TABLE 2.- SUMMARY SHOWING ESTIMATED COST OF DELAYS BASED UPON AN ESTIMATED DAILY COST OF SHOVEL OPERATION OF $65.

KIND OF DELAY	TOTAL TIME LOST PER SHOVEL		PERCENTAGE OF TIME LOST IN 46 DAYS OPERATION PER SHOVEL		ESTIMATED AVERAGE DAILY COST OF TIME LOSSES PER SHOVEL	
	STEAM	GAS-AIR	STEAM	GAS-AIR	STEAM	GAS-AIR
	HOURS	HOURS	PER CENT	PER CENT		
MECHANICAL	13.50	64.25	3.67	17.45	$ 2.38	$ 11.35
WEATHER	16.50	8.75	4.48	2.38	2.92	1.55
MISCELLANEOUS	27.67	26.38	7.52	7.16	4.89	4.65
TOTALS	57.67	99.38	15.67	26.99	10.19	17.55

TABLE 3.- ESTIMATED PRODUCTION OF SHOVELS AS DETERMINED BY STOP-WATCH STUDIES

OPERATION	STEAM SHOVELS AT 0.46 CUBIC YARDS PER DIPPER — ANGLE OF SWING IN DEGREES				GAS-AIR SHOVELS AT 0.65 CUBIC YARDS PER DIPPER — ANGLE OF SWING IN DEGREES			
	45	90	135	180	45	90	135	180
LOADING AND DUMPING, SECONDS	15.61	15.61	15.61	15.61	14.40	14.40	14.40	14.40
SWING AND RETURN, SECONDS	3.31	6.63	9.93	13.25	4.51	9.10	13.65	18.20
COMPLETE CYCLE, SECONDS	18.92	22.24	25.54	28.86	18.91	23.50	28.05	32.60
GROSS PRODUCTION, CUBIC YARDS PER HOUR	87	74	65	56	124	100	84	72
NET PRODUCTION (CORRECTED FOR DELAYS), CUBIC YARDS PER HOUR	74	63	55	48	91	73	61	53
EXCESS OF PRODUCTION BY GAS-AIR SHOVELS OVER STEAM SHOVELS, PER CENT					23	16	11	10
ESTIMATED COST PER CUBIC YARD OF LOADING MATERIAL INTO TRUCKS OR TRACTORS, BASED ON $65 PER DAY FOR ALL SHOVELS 1/	$0.11	$0.13	$0.15	$0.17	$0.09	$0.11	$0.13	$0.15

1/ DOES NOT INCLUDE COST OF DRILLING, BLASTING, HAULING OR PLACING IN DUMP.

TABLE 4.- ESTIMATED COMPARISON OF LINN TRACTORS AND MOTOR TRUCKS IN RESPECT TO YARDAGE MOVED AND HAULING COSTS

OPERATION	TIME IN SECONDS FOR VARIOUS HAUL DISTANCES IN FEET													
	LINNS							TRUCKS						
	100 FT.	150 FT.	175 FT.	200 FT.	250 FT.	300 FT.	350 FT.	100 FT.	150 FT.	175 FT.	200 FT.	250 FT.	300 FT.	350 FT.
LOADING, SECONDS	245.0	245.0	245.0	245.0	245.0	245.0	245.0	199.0	199.0	199.0	199.0	199.0	199.0	199.0
ROAD TIME, SECONDS	58.8	88.0	102.5	117.3	146.6	176.1	205.2	60.0	90.0	105.0	120.1	150.0	180.1	210.0
SWITCHING, SECONDS	9.65	9.65	9.65	9.65	9.65	9.65	9.65	15.9	15.9	15.9	15.9	15.9	15.9	15.9
DUMPING, SECONDS	47.6	47.6	47.6	47.6	47.6	47.6	47.6	48.1	48.1	48.1	48.1	48.1	48.1	48.1
DELAYS, SECONDS	75.3	75.3	75.3	75.3	75.3	75.3	75.3	145.0	145.0	145.0	145.0	145.0	145.0	145.0
ROUND-TRIP TIME, SECONDS	436.4	465.6	480.0	494.9	624.2	553.7	582.8	468.0	498.0	513.0	528.1	558.0	588.1	618.0
NUMBER OF TRIPS PER DAY	66	62	60	58	55	52	49	62	58	56	55	52	49	47
CUBIC YARDS CARRIED PER DAY AT 6 C.Y. FOR LINNS AND 3.5 C.Y. FOR TRUCKS	396	372	360	348	330	312	294	217	203	196	193	182	172	164
COST PER CU. YD., DOLLARS	0.063	0.067	0.069	0.072	0.076	0.080	0.085	0.115	0.123	0.128	0.130	0.137	0.145	0.152
EXCESS OF TRUCK COSTS PER CUBIC YARD OVER COST WITH LINNS, PER CENT								83	84	86	81	80	81	79

In Table 5 is given a summary of the actual output of the trucks during the 46-day period of the study. Based upon these figures the average hauling costs per cubic yard are about double those determined from the stop-watch studies. This result indicates the difficulty of selecting data that will accurately represent the average conditions prevailing on the project. As in the shovel data the stop-watch figures should be considered relative and not absolute. Both Tables 4 and 5 indicate, however, that the Linn tractors moved the dirt for one half the cost shown by the motor trucks.

TABLE 5.- SUMMARY OF TRUCK OUTPUT OVER 46-DAY PERIOD

KIND OF TRUCK OR TRACTOR	TOTAL NUMBER OF LOADS	AVERAGE LOAD CU.YDS.	TOTAL YARDAGE MOVED CU.YDS.	ACTUAL TIME WORKED DAYS	COST OF TRUCKS PER DAY	COST OVER 46 DAYS PER CU. YD.	COST FOR ACTUAL DAYS WORKED PER CU. YD.	AVERAGE COSTS PER CU. YD.
LINN-B	1,751	6.0	10,506	39	$25.00	$0.109	$0.093	LINNS
LINN-L	1,532	6.0	8,192	37	25.00	0.140	0.113	$0.113
LINN-W	1,580	5.5	8,690	41	25.00	0.132	0.118	
LINN-P	1,505	5.5	8,278	42	25.00	0.139	0.127	
STERLING-PRICE	1,298	3.0	3,894	29	25.00	0.295	0.186	
STERLING-1	1,351	3.0	4,053	30	25.00	0.284	0.185	TRUCKS
STERLING-2	1,559	3.0	4,677	34	25.00	0.246	0.182	$0.205
MACK-M	704	3.0	2,112	22	25.00	0.545	0.260	
FEDERAL-F	1,061	2.5	2,653	29	17.00	0.295	0.186	
WHITE-5	1,570	3.0	4,710	31	25.00	0.244	0.164	
AUTOCAR-4	1,178	2.5	2,945	32	25.00	0.390	0.272	

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

MOTOR VEHICLE REGISTRATIONS, 1927, 1/
(CALENDAR YEAR) 2/

MV-1 (1927) REVISED
R.B.A.

(COMPILED FROM REPORTS OF STATE AUTHORITIES)

STATES AND DISTRICT OF COLUMBIA	3/ 1927-REGISTERED MOTOR VEHICLES, INDIVIDUALLY & COMMERCIALLY OWNED			OTHER REGISTERED VEHICLES		TAX-EXEMPT OFFICIAL MOTOR CARS AND MOTORCYCLES			NUMBER OF LICENSES, OR PERMITS (AUTOS)			1926 GRAND TOTAL REGISTERED MOTOR CARS AND TRUCKS	YEAR'S CHANGE IN MOTOR VEHICLE REGISTRATIONS		STATES AND DISTRICT OF COLUMBIA
	GRAND TOTAL REGISTERED MOTOR CARS AND TRUCKS	PASSENGER AUTOMOBILES, TAXIS, AND BUSSES	MOTOR TRUCKS & ROAD TRACTORS	TRAILERS 4/	MOTOR-CYCLES	U.S. CARS	STATE AND LOCAL CARS	MOTOR-CYCLES (OFFIC.)	DEALERS	OPERATORS	CHAUFFERS		NUMBER, INCREASE, OR DECREASE (-)	PER CENT	
ALABAMA	243,539	211,633	31,906	1,472	420	167	-	-	3,919	-	1,630	225,930	17,609	7.8	ALABAMA
ARIZONA	81,047	68,597	12,450	-	271	176	815	-	212	400	401	73,682	7,366	10.0	ARIZONA
ARKANSAS	206,568	174,524	32,044	1,977	303	39	736	21	479	-	4,932	209,419	-(2,851)	- 1.4	ARKANSAS
CALIFORNIA	1,693,195	5/ 1,479,411	5/ 213,784	34,126	9,444	1,217	6/ 23,214	461	3,270	129,792	111,193	1,600,475	92,720	5.8	CALIFORNIA
COLORADO	268,432	245,107	23,385	88	1,362	283	-	-	-	-	-	248,613	19,879	8.0	COLORADO
CONNECTICUT	281,521	238,509	43,012	150	3,083	71	2,459	281	5,600	7/ 323,881	-	263,235	18,286	6.9	CONNECTICUT
DELAWARE	47,124	38,037	9,097	243	313	44	-	-	438	7/ 51,945	-	44,834	2,290	5.1	DELAWARE
FLORIDA	394,734	332,979	8/ 61,755	8/ 1,000	1,243	75	3,451	206	2,547	-	4,949	401,562	-(6,828)	- 1.7	FLORIDA
GEORGIA	300,635	262,630	38,005	-	909	934	-	-	792	-	2,563	277,468	23,167	8.4	GEORGIA
IDAHO	101,336	91,306	10,030	186	440	103	1,210	-	406	-	476	94,760	6,576	6.9	IDAHO
ILLINOIS	1,438,985	5/ 1,254,421	5/ 184,564	3,489	6,135	979	10/ -	-	4,594	-	100,398	1,370,503	68,482	5.0	ILLINOIS
INDIANA	813,637	697,359	116,278	6,599	3,501	3,164	4,083	-	2,584		39,212	772,326	41,311	5.3	INDIANA
IOWA	704,203	649,309	54,894	170	1,787	44	2,927	-	2,531	2,964	-	698,998	5,205	0.7	IOWA
KANSAS	501,901	447,273	54,628	-	1,218	192	2,360	-	2,525	-	-	491,276	10,625	2.2	KANSAS
KENTUCKY	285,621	255,892	29,729	-	693	90	1,742	59	1,051	-	8,410	281,557	4,064	1.4	KENTUCKY
LOUISIANA	255,000	216,000	39,000	3,600	510	209	-	-	487	-	14,177	239,500	15,500	6.5	LOUISIANA
MAINE	163,623	132,927	30,696	1,012	1,245	64	1,173	66	1,297	188,975	7,309	151,486	12,137	8.0	MAINE
MARYLAND	276,863	265,768	11,095	616	2,416	1,969	950	-	6,788	33,814	40,679	252,852	24,011	9.5	MARYLAND
MASSACHUSETTS	694,107	614,359	79,748	443	7,245	556	800	-	2,048	102,285	-	690,190	3,917	0.6	MASSACHUSETTS
MICHIGAN	1,154,773	5/ 998,781	5/ 155,992	17,853	3,585	371	10/ -	-	2,128	220,954	76,483	1,118,785	35,988	3.2	MICHIGAN
MINNESOTA	646,682	565,401	81,281	3,286	2,295	252	2,450	-	2,087	-	17,988	630,285	16,397	2.6	MINNESOTA
MISSISSIPPI	218,043	196,239	21,804	2,317	83	74	-	-	656	-	-	205,200	12,843	6.2	MISSISSIPPI
MISSOURI	682,419	610,303	72,116	1,739	1,835	311	1,428	3	2,387	5,230	26,269	654,554	27,865	4.2	MISSOURI
MONTANA	112,735	94,733	18,002	-	156	229	1,158	9	481	-	338	103,958	8,777	8.4	MONTANA
NEBRASKA	373,912	5/ 342,357	5/ 31,555	1,828	1,109	226	1,029	-	3,052	-	-	366,773	7,139	1.9	NEBRASKA
NEVADA	25,776	20,414	5,362	104	99	42	-	-	533	-	-	24,014	1,762	7.3	NEVADA
NEW HAMPSHIRE	96,009	83,415	12,594	565	1,387	22	-	-	541	73,474	43,242	89,001	7,008	7.9	NEW HAMPSHIRE
NEW JERSEY	712,396	586,510	125,886	1,827	6,857	708	6,294	913	2,917	814,593	6,422	651,415	60,981	9.4	NEW JERSEY
NEW MEXICO	59,291	57,643	1,648	193	170	156	630	-	170	-	-	54,996	4,295	7.8	NEW MEXICO
NEW YORK	1,937,918	1,624,535	313,383	6,936	16,347	1,666	12,116	1,262	4,482	1,701,383	616,025	1,815,434	122,484	5.7	NEW YORK
NORTH CAROLINA	9/ 430,499	390,223	40,276	1,618	1,194	429	5,419	-	6,330	-	-	9/ 385,047	45,452	11.8	NORTH CAROLINA
NORTH DAKOTA	160,701	144,830	15,871	-	277	3	-	-	-	-	-	157,822	2,879	1.8	NORTH DAKOTA
OHIO	1,670,734	1,374,402	196,332	12,134	7,749	2,362	9,067	-	26,997	-	-	1,480,246	90,488	6.1	OHIO
OKLAHOMA	503,126	437,776	65,350	-	1,200	530	-	-	-	-	-	499,938	3,188	0.6	OKLAHOMA
OREGON	244,572	223,582	20,990	-	2,030	141	1,132	-	604	39,355	15,769	233,568	11,004	4.7	OREGON
PENNSYLVANIA	1,554,915	1,354,548	200,367	3,780	14,267	1,383	942	-	28,347	1,564,161	-	1,455,184	99,731	6.9	PENNSYLVANIA
RHODE ISLAND	118,014	98,861	19,153	57	1,250	56	671	87	300	136,860	-	110,746	7,268	6.6	RHODE ISLAND
SOUTH CAROLINA	199,635	179,571	20,064	1,387	325	91	-	-	508	-	-	181,189	18,446	10.2	SOUTH CAROLINA
SOUTH DAKOTA	169,652	153,019	16,533	-	229	85	1,019	-	-	-	-	168,230	1,322	0.8	SOUTH DAKOTA
TENNESSEE	294,567	269,086	25,481	4/ -	904	132	2,914	-	632	-	-	279,639	14,928	5.3	TENNESSEE
TEXAS	1,111,407	996,397	115,010	9,826	3,081	2,505	-	-	3,323	41,775	11,490	1,049,869	61,538	5.9	TEXAS
UTAH 11/	93,974	80,730	13,244	-	531	173	-	-	-	-	-	85,380	8,594	10.1	UTAH
VERMONT	79,527	73,308	6,219	-	601	28	-	-	658	-	-	74,033	5,464	7.4	VERMONT
VIRGINIA	337,607	288,666	48,941	466	2,025	1,141	-	253	2,950	-	8,450	322,614	14,993	4.6	VIRGINIA
WASHINGTON	384,583	326,667	57,916	2,072	2,501	637	4,582	144	4,879	397,975	-	363,279	21,304	5.9	WASHINGTON
WEST VIRGINIA	245,819	217,689	28,130	392	1,431	33	1,862	-	13,701	61,600	25,200	227,836	17,983	7.9	WEST VIRGINIA
WISCONSIN	698,289	609,795	88,494	-	2,963	92	668	79	2,949	-	-	662,282	36,007	5.4	WISCONSIN
WYOMING	51,955	45,539	6,416	-	134	209	257	-	306	-	-	49,883	2,072	4.2	WYOMING
DIST. OF COL.	111,680	98,162	13,518	-	1,151	837	2,131	212	1,958	57,014	1,581	111,497	183	0.2	DIST. OF COL.
TOTAL	23,133,241	20,219,223	2,914,018	123,451	120,303	12/ 33,179	101,689	4,056	155,444	5,948,430	1,185,576	22,001,393	1,131,848	5.1	TOTAL

REMARK: REVISION OF TABLE DUE TO INCORRECT DATA FOR STATES OF ARIZONA AND MARYLAND.

NOTE:
1/ THIS TABLE LISTS ONLY THE NUMBER OF MOTOR VEHICLE REGISTRATIONS, LICENSES AND PERMITS: FOR THE FINANCIAL STATEMENT SEE TABLE MV.2 (1927).

2/ ALL STATES REPORT CALENDAR YEAR TOTALS EXCEPT NORTH CAROLINA WHICH REPORTS ONLY 6 MONTHS TOTALS (JULY 1 TO DECEMBER 31), AS THEIR FISCAL YEAR FOR REGISTRATION ENDED JUNE 30.

3/ THE FIRST 3 COLUMNS RECORD THE REGULARLY REGISTERED MOTOR CARS AND TRUCKS WHICH PAY THE REGULAR LICENSE FEES ELIMINATING REREGISTRATIONS AND NON-RESIDENT OWNERS' CARS. THE GRAND TOTAL OF FIRST COLUMN IS SUBDIVIDED AS INDICATED; PASSENGER SERVICE CARS BEING SHOWN IN SECOND COLUMN AND FREIGHT SERVICE, TRUCKS AND ROAD TRACTORS, IN THE THIRD COLUMN. SOME STATES, AS NOTED, CLASSIFY BUSSES WITH TRUCKS. SPECIAL TABLES SHOWING THE EXTENT AND KINDS OF BUS SERVICE FROM NON-GOVERNMENT SOURCES CAN BE FOUND IN THE FEBRUARY 1928 ISSUE OF "BUS TRANSPORTATION."

4/ SOME STATES INCLUDE TRAILERS WITH MOTOR TRUCKS, AS NOTED; OTHER STATES DO NOT REGISTER SAME.

5/ BUSSES INCLUDED WITH TRUCKS.

6/ INCLUDES OVER 8,000 CARS AND TRUCKS OF PUBLIC SERVICE CORPORATIONS EXEMPT BY LAW.

7/ INCLUDES CHAUFFEURS.

8/ TRAILERS (1,000 ESTIMATED) EXCLUDED FROM TRUCKS.

9/ LAST SIX MONTHS OF YEAR REGISTRATION ONLY AS YEAR COMMENCED JULY 1.

10/ OFFICIAL CARS INCLUDED IN FIRST THREE COLUMNS AS $2.00 FEE CHARGED.

11/ PRELIMINARY DATA, SUBJECT TO REVISION.

12/ AS REPORTED IN 1925 BY BUREAU OF BUDGET, AND INCLUDES 7,859 "CARS-AT-LARGE," NOT ALLOCATED TO ANY STATE.

PROPORTIONING CONCRETE MATERIALS BY WEIGHT.

CONTRIBUTED BY A. F. HAELIG OF DISTRICT 7

(NOT FOR RELEASE)

THE METHOD OF PROPORTIONING DISCUSSED IN THIS ARTICLE IS BASED ON A COMBINATION OF THE MORTAR-VOID AND THE WATER-CEMENT-RATIO THEORIES.

WHEN THE CEMENT CONTENT PER CUBIC YARD OF CONCRETE AND THE CEMENT-WATER-RATIO ARE SPECIFIED, THE QUANTITY OF SAND AND COARSE AGGREGATE WHICH WILL GIVE THE DESIRED YIELD AND CEMENT FACTOR ARE THE ONLY VARIABLES TO BE DETERMINED. IF EITHER ONE OF THESE CAN BE FIXED, THE OTHER MAY BE DETERMINED FROM THE EXPRESSION - "THE SUM OF THE ABSOLUTE VOLUMES OF CEMENT, WATER, SAND, AND COARSE AGGREGATE IS EQUAL TO THE VOLUME OF THE RESULTING CONCRETE."

THE DISCUSSION ON PAGES 86 TO 92 OF UNIVERSITY OF ILLINOIS BULLETIN 137 GIVES US A METHOD FOR DETERMINING THE ABSOLUTE VOLUME OF COARSE AGGREGATE IN A UNIT VOLUME OF CONCRETE. A VALUE OF $\frac{B}{B_o}$ FOR THE SPECIFIED CEMENT CONTENT MAY BE SELECTED FROM FIGURES 45 OR 46 OF THE ABOVE MENTIONED BULLETIN, OR DEVELOPED BY EXPERIMENT. AS THIS RATIO FIXES THE ABSOLUTE VOLUME OF COARSE AGGREGATE, WE HAVE BUT ONE VARIABLE REMAINING WHICH MAY BE DETERMINED BY SUBTRACTING THE SUM OF THE ABSOLUTE VOLUMES OF CEMENT, WATER, AND COARSE AGGREGATE FROM THE SPECIFIED YIELD.

PROCEEDING ON THIS BASIS THE FOLOWING FORMULA MAY BE DEVELOPED:

LET THE CEMENT FACTOR BE 1.50 BARRELS OF CEMENT PER CUBIC YARD OF CONCRETE,
THE WATER CONTENT BE $5\frac{1}{2}$ GALLONS PER BAG OF CEMENT, AND
THE RATIO $\frac{B}{B_o} = 0.775$, WHERE B = ABSOLUTE VOLUME OF COARSE AGGREGATE IN A UNIT VOLUME OF CONCRETE AND B_o = DENSITY OF COARSE AGGREGATE. (THIS RATIO HAS BEEN USED IN MICHIGAN AND GIVES WORKABLE HIGH-STRENGTH CONCRETE.)

WITH THE CEMENT CONTENT OF 1.50 BARRELS OR SIX SACKS PER CUBIC YARD, EACH BAG OF CEMENT MUST PRODUCE $\frac{27}{6}$ - OR 4.5 CUBIC FEET OF CONCRETE.

THEN FOR A ONE-BAG BATCH:

YIELD = 4.5 CUBIC FEET OF CONCRETE.
THE ABSOLUTE VOLUME OF CEMENT = 0.49 CUBIC FEET
DO DO DO DO WATER = 0.733 DO DO
1.223 CUBIC FEET.

4.500 - 1.223 = 3.277 CU FT. ABSOLUTE VOLUME OF SAND AND STONE.

ABSOLUTE VOLUME OF COARSE AGGREGATE FOR ONE CU. FT. OF CONCRETE =

$$0.775 \left(\frac{\text{WT. PER CU. FT. OF DRY LOOSE COARSE AGGREGATE}}{\text{S.G. OF C.A.} \times 62.5} \right)$$

SINCE WE WANT 4.5 CUBIC FEET OF CONCRETE -

THE ABSOLUTE VOLUME OF COARSE AGGREGATE PER BAG OF CEMENT =

$$3.49 \left(\frac{\text{WT. PER CU. FT. OF DRY LOOSE COARSE AGGREGATE}}{\text{S.G. OF C.A.} \times 62.5} \right)$$

∴ THE ABSOLUTE VOLUME OF SAND =

$$3.277 - 3.49 \left(\frac{\text{WT. PER CU. FT. OF DRY COARSE AGGREGATE}}{\text{S.G. OF C.A.} \times 62.5} \right)$$

AND THE WEIGHT OF DRY COARSE AGGREGATE TO BE USED PER BAG OF CEMENT =

(1) 3.49 (WT. PER CU. FT. OF DRY LOOSE COARSE AGGREGATE)

AND THE WEIGHT OF DRY SAND TO BE USED PER BAG OF CEMENT =

$$(2)\ \text{S.G. OF SAND} \left[204.8 - \frac{3.49\ (\text{WT. PER CU. FT. DRY LOOSE C.A.})}{\text{S.G. OF C.A.}} \right]$$

THE ATTACHED CHART WILL GIVE THE RESULTS OF EQUATIONS OF 1 AND 2 DIRECT. IN USING THIS CHART IT IS INTENDED THAT THE SPECIFIC GRAVITIES OF THE SAND AND COARSE AGGREGATE BE FURNISHED BY THE LABORATORY. THE FIELD MAN THEN DETERMINES THE AVERAGE WEIGHT PER CUBIC FOOT OF THE DRY LOOSE COARSE AGGREGATE.

LET US ASSUME THAT THE SAND HAS A SPECIFIC GRAVITY OF 2.67, THAT THE COARSE AGGREGATE IS A GRAVEL HAVING A SPECIFIC GRAVITY OF 2.60, AND THAT THE AVERAGE WEIGHT PER CUBIC FOOT, AS DETERMINED IN THE FIELD, IS 100 POUNDS.

Enter the chart on line A at 100 pounds. The weight of dry coarse aggregate is taken directly from the right side of this line and is 349 pounds; then a straight edge is placed across the chart from the 100-pound point on line A to the specific gravity of coarse aggregate (2.60) on line B. This gives a point on the auxiliary line X; then the straight edge is placed from this point to the specific gravity of the fine aggregate (2.67). The weight of dry sand to be used per bag of cement is taken from line Y and is 189 pounds.

In the first operation, an auxiliary point is obtained on line X by connecting the weight per cubic foot of coarse aggregate with the specific gravity of the coarse aggregate. Then this point (on line X) is used in conjunction with the specific gravity of the sand and the weight of sand to be used is read from line Y.

The theories on which this chart is based may be expressed in a general formula:

Where cement factor = C w/C = R

$\frac{B}{B_o} = 0.775,$

S_F = Specific gravity of fine aggregate,

S_C = Specific gravity of coarse aggregate,

W = Weight per cu. ft. of dry loose coarse aggregate,

then the weight of dry coarse aggregate to be used per bag of cement =

$$(3)\quad \frac{5.23W}{C}$$

and the weight of dry sand to be used per bag =

$$(4)\quad 62.5\, S_F \left[\frac{6.75}{C} - \frac{0.084W}{CS_C} - 0.49 - R\right]$$

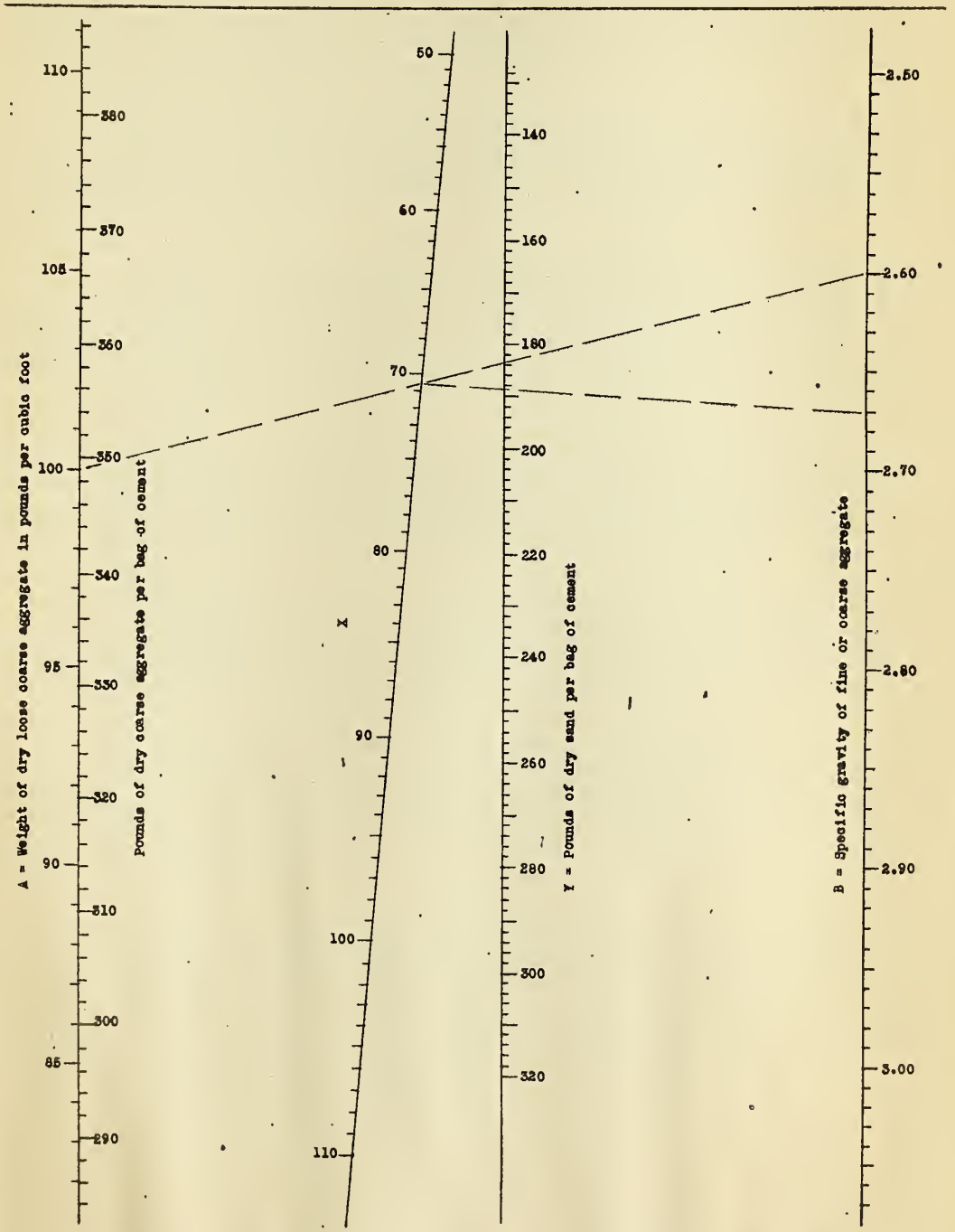
CHART FOR PROPORTIONING CONCRETE BY WEIGHT

Based on

1.50 barrels cement per cubic yard of concrete,

5½ gallons of water per bag of cement,

and the ratio $\frac{b}{b_o}$ = 0.775.



THE REGULATION OF OUTDOOR ADVERTISING BY LAW
(Not for release)

"The Regulation of Outdoor Advertising by Law" is the subject of Bulletin No. 25 issued by the Municipal Art Society with headquarters at 119 East 19th Street, New York City. The author of the bulletin is Mr. Frank B. Williams. Copies may be obtained by applying to the society.

After a preliminary discussion of the problem, Mr. Williams outlines various methods by which interested citizens in the various States may aid the progress of the reform movement, as follows:-

"First, by securing the passage of laws for the stability of billboards, their construction so as not to make fire fighting more difficult, so as not to conceal filth, etc. In so doing they should, incidentally, have regard to the appearance of the billboard.

"Second, by forbidding advertising on public property, making it a crime, giving any person the right to remove it, and making it a presumption that the person advertised authorized the placing of the advertisement on the property.

"Third, by making it a crime to place advertisements on private property without the written consent of the owner, and making it a presumption that the person advertised authorized the placing of the advertisement on the property in question.

"Fourth, by passing State laws authorizing zoning by all the local governments within the State, and seeing to it that proper zoning regulations under which general advertising is confined to business and industrial localities are enacted by all these governments.

"Fifth, by seeking to find occasions (as was done in New York) in which objectionable advertising can be regulated or forbidden on private property, passing statutes for that purpose, and seeing to it that these statutes are vigorously supported in the courts; or by passing a constitutional amendment more or less like that in Massachusetts for the regulation of ourdoor advertising generally."

TABLE OF STATUTES REGULATING OUTDOOR ADVERTISING

"Statutes making the placing of advertisements on public property without consent a crime are marked with a star (*); those giving any person the right to remove it without legal process are marked with a double star (**); those making advertising on private property without the consent of the owner a crime are marked with a dagger (†); statutes making it a presumption that the person whose goods are advertised authorized the unlawful placing of the advertisement are marked with a z (z); statutes taxing outdoor advertising or requiring a license for it, are marked with a double dagger (‡); statutes forbidding advertising obscuring a railroad crossing, etc., are marked with a section (§); other statutes are especially annotated. Statutes authorizing local governments to tax or regulate, and local regulations are not given.

In this table, where the year only is stated, the session laws for that year are meant. Additions to or corrections of this list will be gratefully received.

California, Gen. Law, 1923, Act 89*†; Act 3267, Sec. 6*; Penal Code 1923, Sec. 602, ff, *†.
Colorado, Comp. Laws, 1921, Sec. 7017,*†z; 1923, ch. 128 §.
Connecticut, Gen. Stats. 1918, Secs. 3024, ff,†; 1921, ch. 79,*†; 1925, ch. 249.
Sec. 11 (dropping hand bills &c. from airplane a crime).
Florida, Rev. Gen. Stats. 1920, Sec. 8157.
Hawaii, Rev. Laws, 1925, Secs. 2066, ff,*††.
Illinois, Cahill's Rev. Stats. 1924, ch. 38, Sec. 453, subd. 9,*†.
Indiana, Ann. Stats. (Burns) 1914, Sec. 2320,†.
Iowa Code, 1924, Secs. 4844-5, §; 4846-7,*.
Kansas Rev. Stats. 1923, ch. 19, Sec 2612,§.
Louisiana, 1924, No. 120, *†.
Maine, 1925, ch. 188,*§.
Maryland, Ann. Code. 1924, Art. 39A, Sec. 24*†.
Massachusetts, Constitution, Art. L; Gen. Laws, 1921, ch. 85, Sec. 8, ch. 93, Secs. 29-33, as amended by 1924, chs. 85, 327, 334, 490. See also Gen. Laws 1921, ch. 81, Sec. 9, ch. 85, Sec. 8, and regulations issued under the provisions of ch. 93, above.
Michigan, 1925, No. 359,†; No. 108, Sec. 5*; Sec. 6 §.
Minnesota, Gen. Stats. 1923, Sec. 2615, Subd. 3 *.

Mississippi, 1924, ch. 117, Sec. 3 (amending Code, Sec. 3779)†.
Missouri, 1923, p. 260 (unlawful for employee &c. of city to place advertisements on parks, &c.)
Nebraska 1923, ch. 159 §.
New Jersey, Comp. Stats. 1910, Vol. I pp. 656, 659,†, Cumulative Suppl. 1911-24, *21, **,†z.
New York Penal Law, Secs. 121, 1423, Subd. 11, **†z; 1924, ch. 512 advertising without consent within limit of Adirondack Park - still partly private property - forbidden).
North Carolina, 1924 (extra sess.) ch. 109,*†.
North Dakota, 1925, chs. 145 *§; 182, §.
Pennsylvania, Digest Stats. 1920, Secs. 7967-9,*†; 1925, No. 388*.
Philippines, Admins. Code, 1917, Secs. 1438 †, 1485-7, *.
Offensive signs whether on public or private property may be removed by order of the Collector of Public Revenue. This provision has been sustained by the Courts. See Williams, Law of City Planning and Zoning, p. 392.
Porto Rico, Rev. Stats. and Codes, 1911, Secs. 1-11 *†; 1921, No. 42, Sec. 22†.
Rhode Island, Gen. Laws, 1923, Sec. 6098 **†.
South Dakota, 1925, ch. 186 § (Along highways outside cities and towns, not more than 20 per cent of surface exposed must be red).
Utah, 1923, ch. 27, *†.
Vermont, 1925, No. 32 †§.
Washington, 1923, ch. 129 (Code Suppl. Secs. 10510-3, ff, §.
Wisconsin, Stats. Sec. 4446, b. §."

A.R.B.A. CONVENTION TO BE HELD AGAIN IN CLEVELAND

The annual convention and road show of the American Road Builders' Association will be held for the second time in the public auditorium at Cleveland, Ohio, from January 14 to 18, 1929. The Bureau will display a large exhibit, on the stage of the main auditorium, showing the improvements in the methods of building the principal types of road surfaces during the 26 years since the founding of the Association.

LOCATION OF R.F.D. BOXES UNDER JURISDICTION OF P. O. DEPARTMENT

Contributed by the Legal Section
(Not for release)

Recently the question arose in one of the western States as to what Federal authority had the jurisdiction over the location of rural free delivery mail boxes especially along Federal-aid projects. The State highway department was considerably concerned about the matter because on some Federal-aid projects the boxes were located so close to the travelled way that they interfered with the maintenance operations of the road crews.

There is no agreement between the Bureau and the Post Office Department upon this subject. The erection and location of rural mail boxes along the highways are governed by Sections 816 and 819 of the Postal Laws and Regulations (1924), which read as follows:

> "Sec. 816. Each box shall, if practicable, be erected on the right side of the road regularly traveled by a rural carrier and in such position as to be easily and safely accessible for the delivery and collection of mail by the carrier without leaving his conveyance.
>
> 2. Patrons shall, as far as practicable, keep clear the approaches to their boxes by promptly removing obstructions which may render difficult or impossible the delivery of mail by the carrier."
>
> "Sec. 819. Rural carriers shall make report to postmasters of any boxes erected which do not conform with the regulations in the matter of type, condition, location, or inscriptions, and to the owners of these boxes the postmaster shall send Form 4056 (Notice to patron of irregularity in rural-mail box), requesting that the irregularities or defects be remedied. If, after a reasonable time, any patron fails to comply with the requirements the postmaster shall make report thereof to the Fourth Assistant Postmaster General, Division of Rural Mails, giving the name of the patron and a statement as to what is required in connection with the box. The same action shall be taken by postmasters in respect to

boxes which they note in making the semi-annual inspections required by section 721 are not in conformity with the regulations. The form (4056) should be obtained by requisition on the Division of Equipment and Supplies."

From the above it will be observed that no definite place upon the roadway is prescribed, the requirement being that boxes shall be in such position as to be easily and safely accessible to carriers without leaving their conveyances. This matter has been taken up with the Rural Mail Section of the Post Office Department. They have advised that the proper thing to do in any case involving the position of a rural mail box along the highway is for the proper officials of the State, having jurisdiction over the highway in question, to take the matter up with the postmaster at the Post Office from which the rural route emanates. They advised further that if the matter were taken up with the postmaster he would bring it to the attention of the patron whose box might happen to interfere with traffic upon the highway and arrange to have the box moved so as to avoid such interference. The Post Office Department advises that adjustments of matters of that kind are always handled with the local postmasters and that the Department here does not undertake to make such adjustments.

OBSERVATIONS ON OIL-PROCESSED SURFACES IN THE WESTERN STATES

Compiled from a report made by
W. N. Frickstad of the Regional Office
(Not for release)

The following observations were made on a field inspection trip, early in the summer of this year, in the States of California, Idaho, New Mexico, Utah, and Wyoming.

1. No defective work was found that was unmistakably due to the lack of oil, but considerable corrugating, shoving and rutting was observed because of too much. More movement may be expected by the end of the summer, and even one or more years hence. There seems to be some misinterpretation of the oil stain plates published in the pamphlet on "Light Asphaltic Oil Road Surfaces". The ink used in the reproduction is darker than the natural oil and any attempt to produce a mixture that will give the general color effect of the printed plates will result in excessive "fatness". Three samples were taken from a very successful project carrying probably 2,500 veh cles per day, of which at least twenty per cent were trucks. The stains were barely discernible, two of them being merely slight discolorations of the white paper. It is probably true, however, that a slightly heavier stain should be expected in high altitudes where the summer season is only two or three months in length and where the traffic is relatively light. The general tendency, however, is to use too much oil.

2. Subgrade weakness and inadequate depth of metal are more in evidence upon oiled roads than upon untreated roads. Dust fills the fine cracks in an untreated road and obscures incipient failures. Ruts and more serious breaks are easily repaired by the addition of new material. A wet subgrade on an untreated road dries out by evaporation. But upon a treated road every defect is obvious to a casual observer and moisture does not readily leave the subgrade. Satisfactory repairs of failures contributed to by a wet subgrade are almost impossible without removing the entire surface, an operation which is inconvenient for traffic and which attracts much attention from highway officials and the travelling public.

No road should be treated except as an obviously temporary measure unless the foundation is satisfactory and the thickness of surfacing is adequate to support the loads.

3. Some raveling was observed in all the States where work was done last year. With the exception of two projects, the amount was insignificant. The principal cause seems to be imperfect (incomplete) mixing. Probably defective grading, particularly lack of fines, may be a contributing cause in some instances.

4. Most of the imperfections in the mixing are caused by the failure to turn the material a sufficient number of times. Some lean spots, however, are introduced by tilting the blade or running the blade too close to the base during the last few turnings. The edge of the blade should be held parallel to the transverse contour of the base throughout its operation. To avoid bringing up uncoated material in the last turnings, most successful operators use a method which they describe as "laying down a paint coat". When the mixing is about two-thirds completed, about one-half inch of mixed material is allowed to remain upon the base during the subsequent turnings. Thereafter a slight deviation in the movement of the blade merely dips into this "paint coat" and fails to bring any uncoated material into the mixture.

5. Two wasteful methods were noticed in the blading operations. (a) In two States the movement of the windrow with the heel of the blade was being attempted - quite ineffectually. All movement of course should be done with the toe of the blade so that the material passes backward. (b) In one State much effort was being wasted by "working from a fat to a lean mixture". After harrowing, the upper strata of material would be thoroughly mixed with the blade, becoming thereby too rich. A small amount of additional material would then be brought from below by the blade and thoroughly mingled with the rich mixture, requiring a full number of turns to produce uniformity. The resulting windrow would then be too rich and additional material would be brought from below, with another full series of turns. This process was continued until the mixture was deemed of the right consistency, but in the meantime the material had been turned double or treble the times that should have been necessary.

6. In two other States, the harrows and blades were operated at full speed, approximately 4.0 to 4.5 miles per hour. This is much faster than seems to have been customary heretofore.

The effectiveness of both kinds of equipment is increased remarkably at the higher speed. In fact in one State the disc has become so effective at high speed that it is planned to use two discs and reduce the number of turns with the grader. This State obtained its most satisfactory results with the one-man maintainer type of machine, using the heaviest blade available, powered by a 2-ton caterpillar.

7. Very satisfactory running surfaces have been secured with rock of a maximum size of 1 inch, but it is becoming clear that the most economical results are obtained when the maximum size is limited to 3/4 of an inch. On one project, as an illustration, a definite layer of large stone is being brought to the top by the finishing operations, and is wasted. Similar effects were noted on other projects.

8. Two States are using a thickened oil-mixed edge. This insures adequate thickness at the edge, where ordinarily the oiled layer is likely to be thin, and tends to remove any loose material in the base near the edge.

9. After laying down the mixture, the States are giving careful attention to maintenance for at least two weeks, using a long-wheel-base blade or a long drag. A broom attached to the drag is reported useful during the first few days.

10. A hard and smooth base underneath the oiled mixture is highly important. Compactness is sometimes uncertain when the base has been recently constructed or when material for mixing is secured by scarifying an old road. The process of "laying down a paint coat" is a material help towards securing a compacted base underneath the oil mixture because this so-called paint coat becomes thoroughly pounded into all irregularities by the action of the blade and wheels of the machinery.